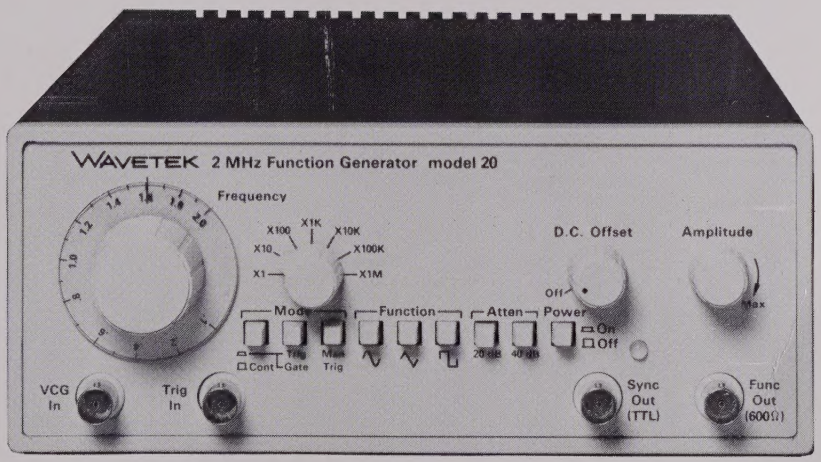
INSTRUCTION MANUAL

MODEL 20
2MHz
FUNCTION GENERATOR



WAVETEK

INSTRUCTION MANUAL

MODEL 20
2MHz
FUNCTION GENERATOR

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SAFETY FIRST

Protect yourself. Follow these precautions:

- Don't touch the outputs of the instrument or any exposed test wiring carrying the output signals. This instrument can generate hazardous voltages and currents.
- Don't bypass the power cord's ground lead with two-wire extension cords or plug adaptors.
- Don't disconnect the green and yellow safety-earth-ground wire that connects the ground lug of the power receptacle to the chassis ground terminal (marked with ⏚ or ⚠).
- Don't hold your eyes extremely close to an rf output for a long time. The normally nonhazardous low-power rf energy generated by the instrument could possibly cause eye injury.
- Don't plug in the power cord until directed to by the installation instructions.
- Don't repair the instrument unless you are a qualified electronics technician and know how to work with hazardous voltages.
- Pay attention to the **WARNING** statements. They point out situations that can cause injury or death.
- Pay attention to the CAUTION statements. They point out situations that can cause equipment damage.

SECTION 1
GENERAL DESCRIPTION

1.1 MODEL 20

Model 20, a 2.1 MHz Function Generator, is a precision source of sine, triangle, square and TTL waveforms plus dc. All functions are front panel variable from 0.002 Hz to 2.1 MHz and can be externally modulated or swept over a 1000:1 frequency range. Output can be continuous, or the generator can be triggered or gated by an external signal or a front panel switch. Amplitude of the waveforms can be varied over an 80 dB range from 10 Vp-p (into 600Ω) down to 1mVp-p. DC reference of the waveforms can be positive or negative offset.

BNC inputs are provided for external voltage control of generator frequency (VCG) and for triggering. BNC outputs are provided for the main functions and for the TTL synchronization output. All inputs and outputs are diode protected against external overvoltages and the main function out has fused protection against accidental connection to line voltages.

The generator operates from external power transformer/battery charger, from an external dc or ac source, or from internal Nicad batteries (not provided).

1.2 SPECIFICATIONS

1.2.1 Versatility

Waveforms
Sine ∿ , triangle ∧ , and square ⊓ .

Operational Modes
Continuous: Generator runs continuously at selected frequency.
Triggered: Generator is quiescent until triggered by external signal or manual trigger, then it generates one complete waveform cycle at selected frequency.
Gated: Similar to triggered mode, except output continues to duration of gate signal. Last waveform cycle started is completed.

Frequency Range
0.002 Hz to 2.1 MHz in seven overlapping ranges.

Function Output
∿ , ∧ , ⊓ selectable and variable to 20 Vp-p (10 Vp-p into 600Ω) at Function Out BNC connector. Step and vernier attenuators provide complete amplitude control down to 2 mVp-p (1mVp-p into 600Ω). Peak output current is 8.3 mA maximum. Source impedance is 600Ω.

DC Offset and DC Output
Waveform offset and dc output is selectable and variable through Function Output BNC. DC output is obtainable by not selecting a function. DC offset control has a continuous range of ± 10V (± 5V into 600Ω) with a calibrated zero offset Off position. DC offset plus signal peak are limited to ± 10V (± 5V into 600Ω) and both attenuated proportionally by the output attenuator.

TTL Pulse Output
TTL pulse (50% duty cycle) at generator frequency. Drives up to 10 LSTTL loads.

VCG — Voltage Controlled Generator
BNC input, up to 1000:1 frequency change with external 0 to ± 2.1V signal. Upper and lower frequencies limited to maximum and minimum of selected range.
Slew Rate: 2% of range per μs.
Linearity: ± 0.5% thru X 100K range; ± 2% on X 1M range.
Input Impedance: 2kΩ.

Trigger and Gate
BNC input accepts analog or TTL compatible external signal to trigger or gate the generator. Input impedance is 10 kΩ shunted by 10 pF. Trigger threshold is + 0.7V, generator triggers on positive-going transition and gates on during positive portion of triggering signal. External signal can have maximum repetition rate of 2MHz and minimum pulse width of 50 ns.

1.2.2 Frequency Precision

Dial Accuracy
± 5% of full scale.

Time Symmetry
Square wave variation from 0.1 to 2.1 on dial less than:
± 1% to 100 kHz;
± 5% to 2.1 MHz.

1.2.3 Amplitude Precision

Sine variation with frequency less than: ± 0.2 dB on all ranges to 100 kHz, referenced to 1 kHz; ± 3 dB to 2.1 MHz, 600Ω load (≤3 feet of 50Ω cable).

1.2.4 Waveform Characteristics

Sine Distortion
Less than:
0.5% on X 1K and X 10K ranges; 1% on X 1, X 10, X 100 and X 100K ranges to 100 kHz.
All harmonics 25 dB below fundamental 100 kHz to 2.1 MHz.

Triangle Linearity
Greater than 99% to 210 kHz.

Square Wave Rise and Fall Time
At function output, less than 150 ns for 10 Vp-p output into 600Ω termination with ≤3 feet of 50Ω cable.

1.2.5 General

Environment
Temperature Range: 20° ± 10°C for specified operation, operates 0° to +50°C, −40° to +75°C for storage. (+60°C max, with batteries installed.)
Warm-up Time: 20 minutes for specified operation.
Altitude: Sea level to 10,000 ft for operation, to 40,000 ft for storage.
Relative Humidity: 95% up to 60°C storage; operating 45% to 50°C and 75% to 25°C at sea level (non-condensing).
Vibration: 5 to 55 Hz with maximum of 2G at 55 Hz.
Shock: 30G, 11 ms half sine.

Dimensions
21.1 cm (8.3 in.) wide; 8.5 cm (3.4 in.) high; 30.5 cm (12 in.) deep.

Weight
3kg (6.6 lb) net; 4kg (8.8 lb) shipping.

Power
Wall transformer/battery charger operates generator from 90 to 110V, 48 to 400 Hz (Opt 001); from 105 to 128V, 48 to 400 Hz (Opt 002); or from 198 to 256V, 48 to 66 Hz (Opt 003). Consumption is less than 10 VA.

Unit also operates from an external ac source of 10 to 18 Vrms or an external dc source of +12 to +25 Vdc. Consumption less than 10VA at lower input values.

Six user-supplied "C" size Nicad batteries with standard 1800 mA-Hr rating, gives approximately 4 hours continuous operation from full charge. Recharge cycle is 15 hours from full drain (indicated by flashing power indicator) with unit on or off while connected to any external power source described above.

WARNING

Use only rechargeable Nickel Cadmium (Nicad) 1.2V cells. A serious explosion danger exists if batteries not designed to be recharged, such as Cadmium Zinc or Alkaline, are connected to the battery charging circuits of the Model 20. Proper batteries (Eveready CH1.8, Panasonic P-180C or equivalent) are readily obtainable.

1.2.6 Options

The Model 20 must be ordered with option 001, 002 or 003. Batteries are not included.

001: Transformer/Batt Charger
90 to 110V, 48 to 400 Hz.

002: Transformer/Batt Charger
105 to 128V, 48 to 400 Hz.

003: Transformer/Batt Charger
198 to 256V, 48 to 400 Hz.

If your Battery Charger is lost or broken contact the factory or your local Wavetek representative regarding replacement.

Transformer /Batt Charger Option Number	Wavetek Part Number
001	1000-00-0489
002	1000-00-0489
003	1000-00-0491

NOTE

All specifications apply for dial between 0.1 and 2, amplitude at 10 Vp-p into 600Ω termination.

SECTION 2
INITIAL PREPARATION

2.1 UNPACKING INSPECTION

After carefully unpacking the instrument, visually inspect all external parts for possible damage. If damage is discovered, file a claim with the carrier who transported the instrument. The shipping container and packing material should be saved in case reshipment is required.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

WARNING

To preclude injury or death due to shock, the rear panel must be connected to an earth ground for external ac, external dc, or internal battery operation. The earth ground can be identified at the facility power connector; of the three terminals, the earth ground terminal is the non-matching shape, usually cylindrical.

CAUTION

To prevent damage to the instrument, check for proper match of line and transformer/battery charger voltage and proper fuse type and rating.

2.2.2 Power Source Requirements

The Model 20 is shipped with transformer/battery charger to match your specified line voltage (see paragraph 1.2.6) and without internal batteries. It can be operated from this transformer/battery charger, from an external ac voltage source of 10 to 18 Vrms, or dc voltage source of +12 to +25 Vdc with or without batteries installed. Battery operation is automatic whenever batteries are installed (see paragraph 1.2.5) and the external source of power is removed with instrument power on. Battery charging is automatic whenever any of the preceding external sources of power are connected, instrument power on or off. Refer to paragraph 5.2 for installation, charging, and care of batteries.

2.2.3 Fuses

The Model 20 uses three internally mounted fuses for power source, battery, and main output protection. These fuses remain the same type and value regardless of type of power source or line voltage. Refer to paragraph 5.3 for fuse service.

2.2.4 Signal Connections

Use 3 foot RG58U 50Ω shielded cables equipped with male BNC connectors to distribute all input and output signals.

NOTE

Signal ground is common to chassis ground terminal located on rear panel. This chassis ground should be connected to earth ground on the chassis of equipment containing the external power source or in battery only operation to chassis of equipment under test. Floating of signal/chassis ground of this equipment more than ± 42V with respect to earth ground is a hazard to operators.

2.3 ELECTRICAL ACCEPTANCE CHECK

This checkout procedure is a general verification of generator operation and can be used for receiving inspection or post-repair checkout.

A two channel oscilloscope, four 3 foot 50Ω coax cables with male BNC connectors, a coax tee connector and an additional function generator are required for this procedure. Preset the generator front panel controls as follows:

CONTROL	POSITION
Frequency Dial	2.0
Mode	Cont (released)
Function	⌐⌙
D.C. Offset	Off (ccw)
Amplitude	Max (cw)
Frequency Range	X1K
Atten	0 dB (both released)

Set up the oscilloscope, Model 20, and external function generator as shown in figure 2-1 and perform the steps in table 2-1.

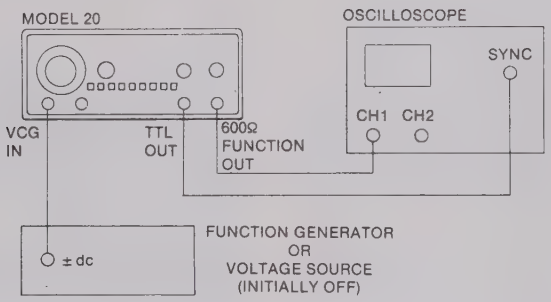

Figure 2-1. First Setup

Table 2-1. Initial Checkout

Step	Control	Position/Operation	Observation
1	Power	ON	± 10V square wave on CH1.
2	Atten	20 dB depressed	± 1V square wave.
3		20 dB released, 40 dB depressed	± 0.1V square wave.
4		Both depressed	± 0.01V square wave.
5		Both released	± 10V square wave.
6	Frequency Dial	Rotate either direction. Return to 2.0.	Rotation ccw increases frequency of rotation cw decreases frequency.
7	Frequency Range	Each position sequentially; return to × 1K.	Frequency increases in decade steps, left to right.
8	Amplitude	Rotate ccw.	Amplitude decreases.
9	D.C. Offset	Rotate cw. Return to Off.	Output immediately offset negative, then moves positive. Off returns it to original level.

Table 2-1. Initial Checkout (Continued)

Step	Control	Position/Operation	Observation
10	Amplitude	Rotate cw.	Square returns to original amplitude.
11	Function Generator or DC Voltage Source	Vary input dc voltage; then disconnect VCG In input.	Frequency increases with positive voltage and decreases with negative voltage.
12	Function	Press ∿ , ⊓ , ⩘ .	Observe ∿ , ⊓ , ⩘ waveforms.
13	Mode	Gate (Cont depressed, Trig/Gate released).	A dc level near zero volts (except ⊓ function).
14	Man Trig	Press and hold.	Continuous ∿ in ⩘ function.
Set up trigger source as shown in figure 2-2. Set trigger source for 100 Hz TTL signal.			
15	——	———	⩘ gated on during positive portion of TTL signal on CH2.
16	Trig/Gate	Trig (depressed).	One ⩘ cycle per trigger cycle.

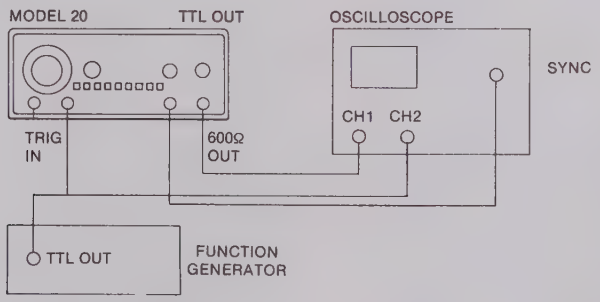

Figure 2-2. Second Setup

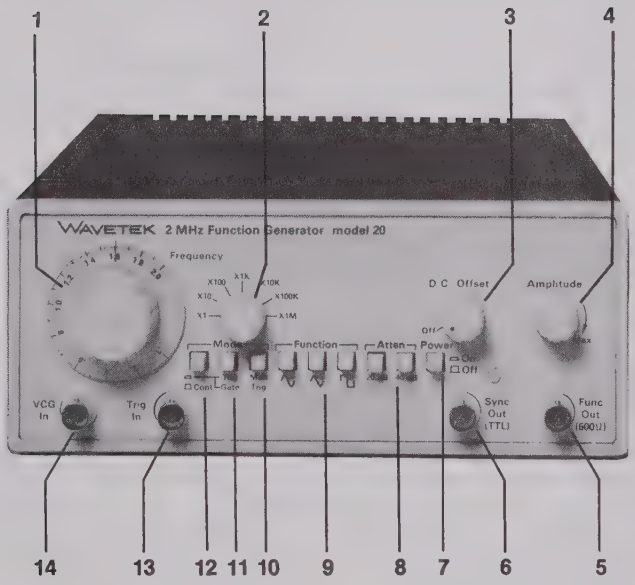

Figure 3-1. Controls and Connectors

SECTION 3
OPERATION

3.1 CONTROLS AND INDICATORS

The generator front panel controls and connectors are shown in figure 3-1 and keyed to the following description.

1 **Frequency Dial —** Setting under the dial index mark summed with **14** and multiplied by **2** determine the output signal frequency.

2 **Frequency Range —** Selects one of seven frequency multipliers for dial **1** setting.

3 **DC Offset Control —** Offsets the Func Out (600Ω) **5** waveforms or gives dc levels from −10V to +10V (−5V to +5V into 600Ω). An Off position ensures no offset.

4 **Amplitude Control —** CCW rotation reduces waveform amplitude at Func Out (600Ω) **5** by 20 dB. DC and offset voltages are not affected by this control.

5 **Func Out (600Ω) Connector —** The main output of the generator at the function selected. Maximum 20 Vp-p (10 Vp-p into 600Ω) with 80 dB amplitude control. 600Ω source impedance.

6 **Sync Out (TTL) Connector —** A TTL square wave for each cycle of the generator. To be used for synchronization or as a TTL signal source capable of driving 10 LSTTL loads.

7 **Power Button —** Turns generator On or Off.

8 **Attenuator Buttons —** These buttons select the attenuation range of the Func Out **5** signal. The Amplitude control **4** allows continuous level variations (20 dB) within each attenuator range. Each of the two buttons may be used individually for 20 or 40 dB steps, or both pressed for 60 dB of attenuation. The attenuation attenuates both the waveform and dc offset.

9 **Function Selector —** Selects one of three waveforms (∿ , ⩘ , ⎍) or when all three buttons are released, a dc level.

10 **Man Trig Button —** Triggers or gates the output signals when generator mode is Trig or Gate. In trigger mode, one waveform cycle is output when the button is pushed. In gate mode, waveform cycles are continuously output as long as the button is held in.

11, 12 **Mode Controls —** Selects one of the following three modes:

Cont — 12 released. Continuous output at Func Out (600Ω) **5** and Sync Out (TTL) **6** connectors.

Trig — 11 and **12** pressed. DC level output until generator triggered by the Man Trig **10** or with a signal at the Trig In connector **13**. When triggered, the generator output is one cycle of waveform followed by a dc level.

Gate — 11 pressed and **12** released. As for Trig except the output is continuous for the duration of the manual or external trigger signal. The last cycle started is always completed.

13 **Trig In Connector —** Accepts either an analog or TTL signal to trigger or gate the generator. Input impedance is 10 kΩ shunted by 10 pF. Triggering threshold is +0.7V. Triggers on rising (low to high) transition and gates during the portion of the triggering signal which is more positive (high) than the threshold.

14 **VCG In Connector —** Accepts ac or dc voltages to proportionately control a frequency within the range determined by Frequency **2.** Positive voltages increase the frequency set by the dial **1**; negative voltages decrease the frequency. The VCG In will not drive the generator frequency beyond the normal dial limits of a range. Input impedance is 2kΩ.

3.2 OPERATION

Perform the initial checkout procedure in Section 2 for a feel of the instrument. Any questions concerning individual controls and connectors may be answered in paragraph 3.2. Bold numbers are keyed to figure 3-1. Outputs are shown in figure 3-3.

3.2.1 Signal Termination

Proper signal termination, or loading, of the generator connectors is necessary for its specified operation. For example, figure 3-2 shows proper termination of the Func Out (600Ω) connector. Placing the 600Ω terminator, or 600Ω resistance, in parallel with a higher impedance, matches the receiving instrument input impedance to the coax characteristic and generator output impedance, thereby minimizing signal reflection or power loss on the line due to impedance mismatch.

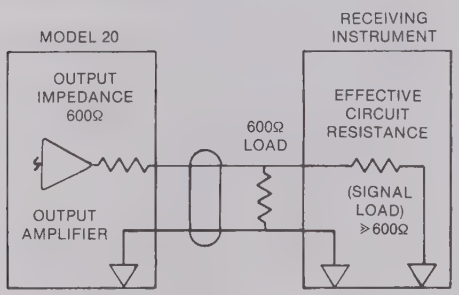

Figure 3-2. Signal Termination

NOTE

Because most common coax cables have 50Ω characteristic impedance, the 600Ω source and load impedance does not match the cable's impedance. It is recommended that if 50Ω coax cables are used they be 3 feet or less in length, otherwise this will result in roll off at higher frequencies.

The Func Out (600Ω) may be terminated with 50Ω providing an output of no more than 1.5 Vp-p is needed. Thus, 50Ω coax cables lengths of 3 feet or greater may be used with negligible amplitude roll-off to 2MHz; square wave rise and fall time is ≈70 ns (50Ω coax ⩾3 feet).

The input and output impedances of the generator connector are:

Connector	Impedance
Func Out (600Ω)	⩽600Ω
Sync Out (TTL)	*
Trig In	10 kΩ, 10 pF
VCG In	2 KΩ

* The Sync Out can drive up to 10 LSTTL loads (Low: 0 to 0.4V, high: 2.4 to 5V). Should be terminated with 600Ω resistive load.

3.2.2 Input/Output Protection

The Function Out (600Ω) is short circuit and fuse protected against accidential application of high or line voltages. If the output appears to be open circuit the fuse has probably been blown; refer to paragraph 5.2 for fuse replacement.

The remaining inputs and outputs are protected with diodes between ground and normal supply voltages. In addition, the LSTTL integrated circuit driving the Sync Out has been mounted on a socket for ease of replacement in case the Sync Out (TTL) signal is accidentally connected to a high voltage.

3.2.3 Manual Function Generator Operation

Frequency Selection: Select any one of the seven Frequency ranges **2.** Output frequency is the product of dial **1** setting and the selected range.

Mode Selection: Continuous operation is selected when the Cont switch **12** is out.

Function (waveform) Selection: Select one of the Function switches **9**. Corresponding waveform will be available at the Func Out (600Ω) connector **5**.

Amplitude Adjustment: The amplitude of the selected waveform at the Func Out connector **5** can be set with the Amplitude control **4** and the Attenuator switches **8**. The Sync Out (TTL) amplitude is a fixed level not affected by Amplitude, Attenuator **8** or DC Offset **3** controls.

D.C. Offset Control: With D.C. Offset **3** full ccw in Off position, the waveform at the Funct Out is symmetrical around signal ground. With the D.C. Offset **3** control out of the Off detent, offset of the Func Out **5** is continuously variable ± 10 Vdc open circuit (± 5 Vdc into 600Ω). For large values of offset plus waveform and oscilloscope should be used to verify that the combination of the two is not too great so as to cause clipping of the waveform peaks.

3.2.4 DC Output

Select the DC function by releasing the three Function switches **9**; depress a released switch slightly just

enough to pop out the selected switch. The Func Out now becomes a variable DC supply using the D.C. Offset **3**. With DC function selected, the generator is prevented from running at selected frequency to ensure a clean dc output.

3.2.5 Voltage Controlled Function Generator Operation

Operation as a voltage controlled function generator (VCG) is as for a manually controlled function generator, only the frequency within particular ranges is additionally controlled by an external voltage (±2V excursions) injected at the VCG In connector **14.** Perform the steps given in paragraph 3.2.3, except set the frequency dial to determine a reference from which the frequency is to be voltage controlled.

1. For frequency control with positive dc inputs at VCG In, set the dial for a lower frequency limit.
2. For frequency control with negative dc inputs at VCG In, set the dial for an upper frequency limit.
3. For modulation with an ac input at VCG In, set the dial at the desired center frequency. Do not exceed the maximum dial range of the selected frequency range.

NOTE

Nonlinear operation may result when the VCG input voltage is excessive; that is, when the attempted generator frequency exceeds the range limits. The upper limit is twice the multiplier setting, and the lower limit is 1/1000th of the upper limit.

The up to 1000:1 VCG sweep of the generator frequencies available in each range results from a 2V excursion at the VCG IN connector. With the frequency dial set to 2.0, excursion between −2V and 0V at VCG IN provide the up to 1000:1 frequency sweep. With the dial set to .002, excursions between 0V and +2V at VCG In provide the up to 1000:1 sweep within the set frequency range.

3.2.6 Triggered or Gated Operation

Set up as in paragraph 3.2.3. The selected frequency will now determine the period (1/f) of triggered cycles. The external generator (triggering source) frequency will determine the repitition rate of triggered cycles or gated bursts. Select the triggered or gated mode by depressing the Cont **12** switch. Select trigger mode by depressing or gated mode by releasing the Trig/Gate switch **11**. Connect the external trigger signal (a lower frequency than the Model 20's selected frequency) to the Trig In connector **13**. The external trigger signal may be TTL or bipolar analog as long as it has a high level >0.7V and a low level <0.7V. Figure 3-3 demonstrates possible waveforms and relative timing of waveforms for all three modes of operation.

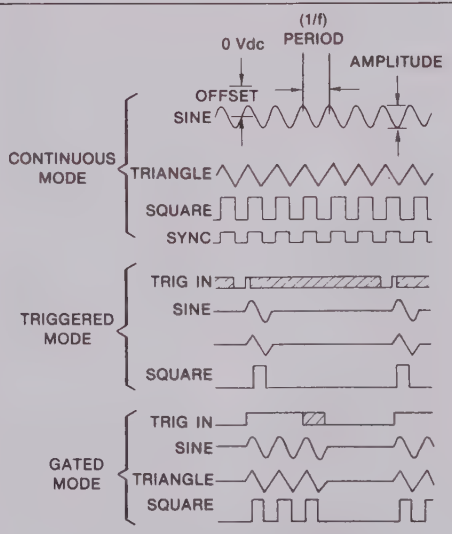

Figure 3-3. Waveform Characteristics

SECTION 4
CIRCUIT DESCRIPTION

4.1 THE MODEL 20

This section describes the functions of major circuit elements and their relationships to one another as shown in schematic 0103-00-1323 in Section 7 of this manual. The following sections in this manual provide more detailed information for maintaining the instrument.

4.2 VCG

As shown in the schematic, the VCG (U1A) sums voltage inputs from the frequency dial and the VCG In connector. This sum voltage controls the magnitude of a complementary current source and current sink (U1B, U2). This current varies linearily from approximately 1 mA to 1 μA and over the 1000:1 (2.0 to .002) range of each frequency multiplier. The VCG also controls the trigger baseline compensation circuit (Q1), which consists of another current sink at twice the current magnitude.

4.3 GENERATOR LOOP

The current switch (U3), controlled by the comparator output (± 2V square), connects either the current source or the current sink to the timing capacitor selected by the frequency range switch SW1. When the current source is switched in the comparator is high and the charge on the timing capacitor will rise linearily, producing the positive-going triangle slope. Likewise, the current sink produces the negative-going triangle slope.

The triangle buffer (Q2, Q3, Q4, U4) is a unity gain amplifier to convert the instantaneous charge on the integrating capacitor to the triangle function which is fed to the comparator and to the output circuits. The comparator (U5, Q5, CR10 – 13) operates as a window detector with limit points set to the triangle peaks. The ± 2V output from Q5 is sent back to the current switch and to the output circuits. When the output is + 2V, the triangle is positive-going until the + 1.25V limit is reached and the comparator output switches to – 2V. When the output is – 2V, the triangle is negative-going until the – 1.25V limit is reached and the comparator output switches back to + 2V, repeating the process. In this manner, the basic function generator loop produces simultaneous generation of triangle and square waves at the same frequency.

The output frequency is determined by the magnitude of the timing capacitor selected by the frequency range switches (SW1) and by the magnitude of the currents supplied to and removed from it. Since the currents are linearily proportional to the sum of the VCG inputs, so will be the output frequency.

To extend the lower frequency capability of the generator, a capacitance multiplier circuit divides VCG currents by 10 (effectively multiplying the timing capacitor by 10) for each of the lower three frequency ranges. This is accomplished through the action of SW1A, SW1B and R13 – 17.

The TTL square from comparator U5 pin 9 is buffered by U6B and sent to the Sync Out (TTL) connector. It is also sent to the trigger flip-flop (U7B) and to a level shifter (Q5) to produce the ± 2V bipolar square for the current switch, the diode bridge of CR10 – 13 (which produces the ± 1.25V reference to compare to the triangle peaks) and to the square function switch SW2F at the function selector input. The triangle is also sent to the function selector input at SW2F1 and to the triangle function switch SW2E1 at the function selector output.

4.4 FUNCTIONS

In sine function the input to the function selector is the triangle waveform and the U8 circuitry converts the triangle into sinusoidal varying currents for the preamplifier. In square function, U6A is enabled and Q6 level shifter and SW2F1 pass ± 2V square to U8 circitry where it is clamped and shaped into square wave currents for the preamplifier. The triangle function SW2E1 connects the triangle to the preamplifier summing node through a scaling resistor.

4.5 PREAMPLIFIER AND OUTPUT AMPLIFIER

The selected function is sent to the preamplifier (U10), where it is inverted and buffered. The preamplifier output goes to the output amplifier through the Amplitude control where it is summed with offset voltage from the D.C. Offset control. Here, waveform and offset are inverted and amplified to a 10V peak signal which can drive a 600Ω termination from a 600Ω source impedance. Two "tee" attenuators of – 20 dB (1/10) and

– 40 dB (1/100) may be switched in or out before applying the main output to the Func Out (600Ω) BNC.

4.6 TRIGGERED AND GATED

Noncontinuous modes of operation (trigger and gate) result from allowing or preventing the VCG current source from charging the timing capacitor. Whenever the trigger flip-flop outputs (U7B pin 9) is low, each of the two trigger diodes (in U3) conduct a current I, sourcing 2I to the baseline compensation circuit (Q1). This removes the current I from the VCG current source and forces a 0V baseline at the triangle amplifier input.

When the Cont switch (SW2A1) is released, trigger logic is inhibited from passing any trigger signals and the trigger flip-flop output is held high. This prevents the trigger diodes from conducting and the generator loop operates continuously.

When the Cont switch is pressed, the generator loop is held at the 0V baseline. Pressing the Trig/Gate switch (SW2B2) puts the instrument in triggered mode and any external or manual trigger signals at the trigger logic input (U5 pin 1) will be transformed into a narrow pulse corresponding to the low-to-high transition of the trigger input. This pulse sets the trigger flip-flop high and allows the generator loop to run. When the triangle negative peak is reached, the comparator low-to-high transition clocks the trigger flip-flop low and, when the 0V baseline level is reached, the generator loop again stops. The result is a single waveform generated after the triggering signal corresponding to 0 to 360° of phase. Successive triggered waveforms always start at the some 0° point.

Releasing the Trig/Gate switch puts the instrument in the gated mode. This is identical to the triggered mode, except the trigger flip-flop is held high for the full duration of the triggering signal. The generator produces continuous waveforms during the time the external signal is high or the manual trigger switch is held in. The last triggered cycle started is always completed and successive gated bursts always start at the 0° point.

4.7 DC OFFSET

Releasing all three function switches causes the generator to stop at the 0° baseline position through the action of SW2F2, SW2D2 and SW2E2 resetting the trigger flip-flop. This results in dc output function.The dc level is controlled by the D.C. Offset control.

4.8 POWER SOURCE

External power is rectified and applied to the Battery Charger (U13), a constant voltage-constant current charging circuit. R109 in the feedback limits charging currents to a safe level. The 9.4V (or battery voltage) output is applied through the Power switch SW2I to the Indicator Flasher and Regulators.

U11A and U11B circuitry is a low frequency free-running oscillator normally prevented from oscillating unless the low battery line from U12 pin 8 is low. U11C drives the power indicator LED (CR46) continuously on when the battery voltage is high (charged) or no batteries are installed. When battery voltage drops below 1 volt per cell the indicator flashes.

Regulator U12 acts as a step-up switching regulator with L1 the energy storage element and Q10 the switching element. Plus and minus 15 volt supplies are generated from the switcher and the – 5 volt supply is produced from – 15V by 10V zener diode CR50. The + 5 volt supply is produced directly from the battery voltage by three-terminal linear regulator U14.

SECTION 5
MAINTENANCE AND ALIGNMENT

5.1 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for alignment or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

5.2 BATTERY MAINTENANCE

5.2.1 Battery Installation

Refer to paragraph 1.2.5 for battery specifications.

CAUTION

To avoid dangers associated with recharging batteries, use only Nickel-Cadmium (Nicad) 1.8 Amp-Hour "C" cells. Do not attempt to use any battery type that is not designed to be recharged.

To install the batteries, perform the following steps.

1. Remove top cover (paragraph 5.4.1).
2. Install six cells into the holder; ensuring the cells are installed in the correct polarity as indicated on the battery holder.
3. Rotate each cell inside the holder 1/2 revolution to ensure all contacts are seated and making good connection.
4. Replace the cover (paragraph 5.4.2).
5. For battery charging, refer to paragraph 5.2.2.

5.2.2 Battery Charging

The battery is being charged whenever the instrument is connected to external power (paragraph 1.2.5). The constant voltage-constant current charger charges a discharged battery at a rate of 1/10 capacity (180 mA) over a 16 hour charge cycle and gradually drops off to a 60 mA trickle charge at full battery voltage. The cycle is the same 16 hours whether the unit is operated with power on or not.

NOTE

If the batteries have been completely discharged, charge the battery with the Power switch Off for a few minutes before operating, so that it can be operated with the power indicator illuminated and not flashing.

5.2.3 Battery Care

Avoid operating the instrument on batteries after the power indicator starts flashing. A completely discharged battery will eventually fail if allowed to discharge completely and repeatedly. Make sure to charge newly purchased batteries at least 15 minutes before operating the instrument. When batteries are installed, leave the unit connected to external power whenever possible.

Cycle batteries between full charge and full discharge (flashing power indicator) regularly even if external power is always available; this will keep batteries at full capacity.

Test the batteries on a regular maintenance cycle according to paragraph 5.2.4.

When batteries are installed, avoid storage where ambient temperature exceeds +60°C.

5.2.4 Battery Test

Test the batteries on scheduled maintenance/calibration cycle.

1. Charge batteries for 16 hours.
2. Remove the top cover (paragraph 5.4.1).
3. Measure the voltage across each cell in the holder with external power removed and the instrument's Power switch On and the power indicator constantly illuminated. All cells should measure between 1.35 and 1.45 volts and be well matched. Remove and replace any cells with a much lower voltage, and recharge all new cells.
4. Test battery capacity by operating the instrument with external power removed until the power indicator begins to flash; the instrument should operate for at least two hours on batteries. If not, continue the charge/discharge cycles (paragraph 5.2.3) until capacity is improved. if capacity cannot

be obtained, replace all six batteries (paragraph 5.2.1) and return to step 1 of this test.

5. Continue other maintenance procedures.

5.3 FUSE REPLACEMENT

If unit does not power on with external power, F1 may be blown. If unit has batteries installed, yet operates from external power and not from battery power; F2 may be blown. If unit operates with power indicator on, TTL output at Sync Out and no output at Function Out (600Ω); F3 may be blown. Fuse locations are shown in figure 5-3.

To replace a fuse, use the following procedure.

1. Remove top cover (paragraph 5.4.1).
2. Locate suspected fuse with figure 5-3 and table 5-1 and test for open/short (power removed) with ohmmeter. If open, replace fuse according to table 5-1.

WARNING

Do not replace a blown fuse with one which has a larger rating or slower lag time than those specified.

3. Test unit.
4. Replace cover if operation is normal.

Table 5-1. Fuse Replacement

Fuse Reference	Fuse Purpose	Fuse Type
F1	Power input protection	3AG 1.5A Slow Blow
F2	Battery protection	3AG 1.5A Fast Blow
F3	Function out protection	3AG ¼A Fast Blow

5.4 COVER REMOVAL AND REPLACEMENT

5.4.1 Cover Removal

Remove the top and bottom using the following steps and figure 5-1.

1. Remove two (2) screws holding top and bottom covers to rear panel.
2. Slide both covers (together as a unit) to the rear and remove from the chassis assembly.

5.4.2 Cover Replacement

1. Turn the instrument upside down, position the bottom cover over the guard shield, and then slide the bottom cover forward approximately two inches while engaging the top cover and slides (see figure 5-2, detail A and detail B). Don't slide the cover on yet.

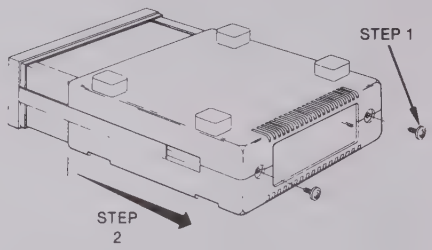

Figure 5-1. Top and Bottom Cover Removal

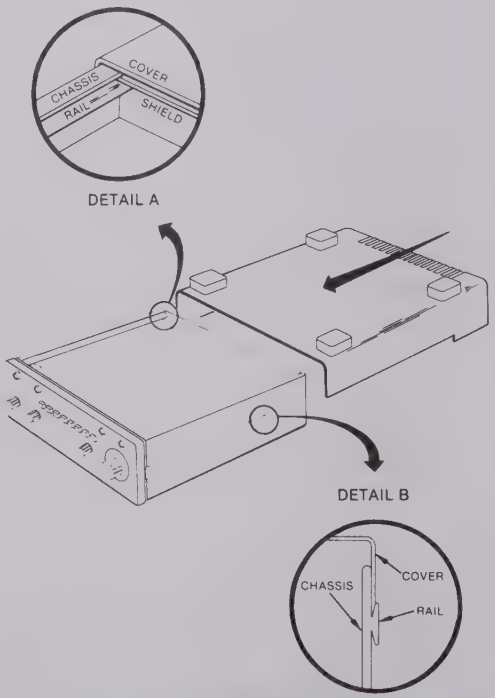

Figure 5-2. Top and Bottom Cover Installation

2. Turn the instrument right side up. Install the top cover using the same procedure as in step 1. Don't slide the cover on yet.
3. Align the rear of both the top and bottom cover with each other so that the cover interlocks are properly mated. Once mated, hold the covers firmly together and slide the chassis assembly into the mated top and bottom covers.
4. Secure covers to unit using two screws as shown in figure 5-1.

5.5 REQUIRED TEST EQUIPMENT FOR ALIGNMENT

Voltmeter . . Millivolt dc measurement (1% accuracy)
Oscilloscope . . . . . ≥60 MHz bandwidth
Counter . . . . . ≥2 MHz (0.1% accuracy)
600Ω Feedthru . . . . . ±1% accuracy, 1W
Distortion Analyzer . . . . To 100 kHz
RG58U Coax Cable . . 3 ft length BNC male contacts

5.6 ALIGNMENT

5.6.1 Preliminary Steps

1. Remove top cover (paragraph 5.4.1).
2. Perform battery test if batteries are installed (paragraph 5.2.4).
3. Obtain required test equipment (paragraph 5.5).
4. With unit on, place top cover over the unit without sliding it on so that unit warms up to operating temperature.

5.6.2 Procedure

After referring to the following preliminary data, perform alignment, as necessary, per table 5-2. If performing partial alignment, check previous settings and adjustments for applicability. See figure 5-3 for alignment control location.

NOTE

The completion of the calibration procedure returns the instrument to correct alignment.

CALIBRATION LIMITS AND TOLERANCES ARE NOT INSTRUMENT SPECIFICATIONS

Instrument specifications are given in Section 1 of this manual.

1. All measurements made at the Function Out connector must be terminated into a 600Ω (±1%) load.
2. Start the alignment by connecting the unit to an appropriate external power source and setting the front panel switches as follows.

   Initial Settings
   Power . . . . . On
   Frequency Dial 2.0
   Frequency Range . . . . . ×10K
   Mode . . . . . Cont (released)
   Function
   D.C. Offset . . . . . Off
   Amplitude . . . . . Max (cw)
   Atten . . . . . 0 dB (released)
3. Allow the unit to warm up at least 30 minutes for final alignment. Keep the instrument cover on to maintain heat. Remove cover only to make adjustments or measurements.

Table 5-2. Alignment

Step	Check	Tester	Cal Points	Control Setting	Adjust	Desired Results	Remarks
1	Power Supplies	Voltmeter	JP1 (rear of C11 gnd)	Initial Settings		+14.0 to +15.0 Vdc	R122 nominal
2			JP3			−14.0 to −15.0 Vdc	
3			JP2			−4.0 to −5.5 Vdc	
4			JP4			+4.75 to +5.25 Vdc	
5	Charger Voltage		TP1		R111	+9.4 ± 0.05 Vdc	If batteries are installed, remove F2 to make this adjustment

Table 5-2. Alignment (Continued)

Step	Check	Tester	Cal Points	Control Setting	Adjust	Desired Results	Remarks
6	Tri. Ampl. Balance	Oscilloscope	Func Out	Frequency: × 100 Dial: .002 (cw)	R126	Slowly changing level rising and falling at approx. same rate.	Free run scope trigger, 0.1 ms/Div horizontal and 2V/Div vertical
7	Output Ampl. Balance	Voltmeter		Frequency: × 10K Dial: 2.0 Mode: Trigger (depress Cont switch) Amplitude: min (ccw)	R62	0 ± 10 mVdc	
8	∿ Baseline			Amplitude: max (cw)	R104		
9	∿ Distortion	Distortion Analyzer		Function: ∿	R44 R48	Minimum Distortion	
10	20 kHz Frequency	Frequency Counter			R2	20.00 kHz ± 0.05 kHz	
11	2MHz Frequency			Function: ∿ , ∿ , ⊓	C7	Best 2.00 MHz Frequency on all functions.	

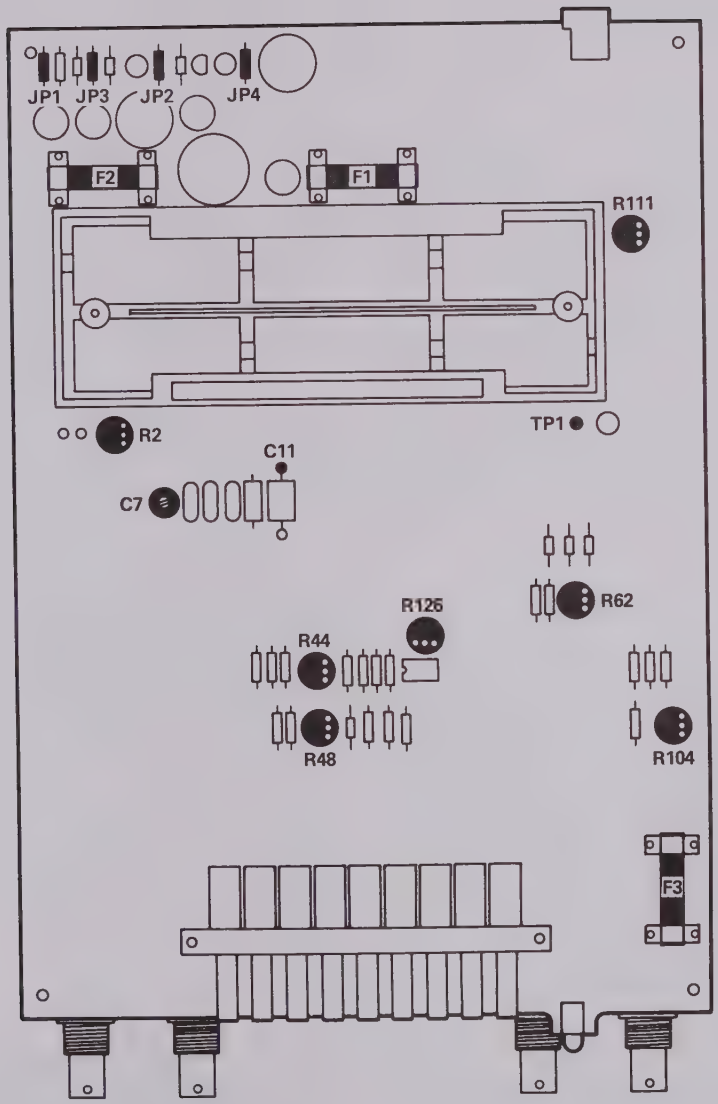

Figure 5-3. Maintenance and Alignment Points

SECTION 6
TROUBLESHOOTING

6.1 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for alignment or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

6.2 TROUBLESHOOTING TABLES

Table 6-1 gives an index of the troubleshooting tables by indications of common problems. The tables do not cover every possible trouble, but, when used in conjunction with circuit description and schematics, will be an aid in systematically isolating faulty components.

6.3 GENERAL INSTRUCTIONS

When encountering a problem, it is advisable to return as many of the front panel controls as possible to their initial settings and still retain the problem. The troubleshooting tables in this section generally begin at these initial settings and specify all subsequent setups. Preset the front panel controls as follows.

Control	Position
Frequency Dial	2.0
Power	On
Frequency Multiplier	1K
Function	⊓
D.C. Offset	Off
Amplitude	Max
Attenuators	Off

CAUTION

To prevent damage to components, turn unit off while removing or replacing components, connectors or pc boards.

The suspected malfunctioning condition should be double checked to eliminate the possibility of improper settings or connections. Before attempting fault isolation, the unit should be checked for proper external power connection (refer to Section 2). A good visual inspection of the boards and chassis wires for damage or overheating often saves much time.

Once the malfunction is defined, begin the isolation procedure by selecting an indication in table 6-1 which best describes the malfunction and proceed to the referenced troubleshooting table.

Follow through the checks in the troubleshooting table, using schematics and assemblies as a guide. When positive results are not obtained, perform the indicated corrective procedure.

Table 6-1. Fault Isolation

Indication	Table
1. Fuse blown, no power indication or no outputs.	6-2
2. Function outputs missing or clipped when TTL sync OK. Triangle problem.	6-3
3. Sine waveform problem.	6-4
4. Square waveform problem. Triangle OK.	6-5
5. TTL sync output problem.	6-6
6. Generator frequency does not respond correctly to dial and VCG input.	6-7
7. Waveform symmetry problem.	6-8
8. Problem on bottom three ranges only.	6-9
9. Generator trigger and gate mode problem.	6-10

Table 6-2. Power Supplies and General Loop

Indication: Fuse blown, no power indication or no outputs.

	Check	If Faulty, Check
1.	Set all controls in their initial positions (refer to paragraph 6.3).	
2.	Ensure power connections (and if applicable, battery installation) are normal (refer to sections 2 and 5). Check F1, F2, F3.	Replace fuse; check for normal operation.
3.	Check cathode of CR45 for +11 to +24 Vdc.	External power, F1, CR45, C55, C56, U13.
4.	If batteries installed, remove F2. Check TP1 for +9.4 Vdc (R111 adjust).	Turn Power switch off, check TP1 again. If still bad, check U13 circuit. If good, isolate loading with JP1 – JP4 and check U12, Q10.
5.	If batteries installed, replace F2. Check TP1 for +6 to +9 Vdc.	Refer to paragraph 5.2.4 for battery tests.
6.	Check JP1 for +14 to +15 Vdc and JP3 for −14 to −15 Vdc.	Lift JP1 – JP4 to isolate loading from generator circuits. If lifting jumpers does not help, check: a) U12 b) Q10 c) U11 d) CR47 – 50 If lifting jumpers restore voltages, the components loading the supply are in the generator circuits. To further isolate components in the generator circuits, lift one end of each component attached to the defective supply line.
7.	Check JP2 for −4 to −6 Vdc.	a) CR50 b) Lift JP2 to isolate.
8.	Check JP4 for +4.75 to +5.25 Vdc.	a) U14 b)Lift JP4 to isolate.
9.	Check for constantly illuminated Power indicator LED CR46.	a) U11 b) U12.
10.	Check U2 pin 13 for a shift from +10V to +15V and pin 7 for a shift from −10V to −15V as frequency dial is rotated from 2.0 to .002. Return to 2.0.	Go to table 6-7.
11.	Check anode CR7 for approximately +2 Vdc.	Go to table 6-10.
12.	Check emitter Q3 for a 2 kHz, ±1.25V triangle.	Go to table 6-3.

Table 6-2. Power Supplies and General Loop (Continued)

Check	If Faulty, Check
13. Check U5 pin 9 for either +4V or 0V.	a) U5 circuit b) ±5V supplies.
14. Check CR15 cathode: +2V if U5 pin 9 is +4V, or −2V if U5 pin 9 is 0V.	Q5 circuit.
15. Check U5 pin 12: +1.25V if U5 pin 9 is +4V, or −1.25V if U5 pin 9 is 0V.	CR10−12 circuit.
16. Check for normal forward diode drop across CR7.	a) CR7 b) U3.
17. Check U4 pin 2 for approximately the same voltage as found in Step 14.	a) U3 b) Q2 c) U4.
18. Check U4 pin 3 for same voltage as U4 pin 2	a) Q2, Q3, Q4 circuits b) U4.
19. Check U5, U3.	Replace U5, U3 if bad.

Table 6-3. Output Circuits

Indication: Function outputs missing or clipped when TTL sync output OK. Problem with triangle waveform.

Check	If Faulty, Check
1. Set controls to initial positions (refer to paragraph 6.3).	Check for normal operation.
2. Check emitter Q3 for a 2 kHz, ±1.25V triangle.	Go to table 6-2.
3. Select triangle function, rotate Amplitude ccw, and check U10 pin 6 for a ±1V triangle.	a) R104 adjustment b) U10 c) SW2E.
4. Rotate Amplitude cw, D.C. Offset to Off, and check Func Out for a 20 Vp-p (open circuit) triangle.	a) Output amplifier circuit; U9, Q8 Q9 b) F3, CR41 − 44 c) SW2G, H.
5. Check for excessive discontinuities at the triangle peaks near the bottom of a frequency range (other than ×1 to ×100).	a) U3 b) SQR signal at cathode CR15 not ±2V.
6. Check for nonlinearities in the triangle slopes near the bottom of a frequency range (other than ×1 to ×100).	a) Associated timing capacitor or C6. b) U3, CR7 c) Q2, U4.
7. Check for a waveform symmetry problem.	Go to table 6-8.

Table 6-4. Sine Conversion

Indication: Sine waveform problem.

	Check	If Faulty, Check
1.	Set controls to initial positions (refer to paragraph 6.3).	Check for normal operation.
2.	Check emitter Q3 for a 2kHz, ±1.25V triangle.	Go to table 6-2.
3.	Verify that the ±1.25V triangle peaks at the emitter of Q3 agree within 3%.	a) R23, R24, CR10 – 13 b) U5 c) ±15V supplies.
4.	Select triangle function; check for ±1V triangle at U10 pin 6.	Go to table 6-3, step 3.
5.	Select sine function; check for ±1V sine at U10 pin 6.	a) U8 circuitry. b) SW2E, F.
6.	Check sine distortion Func Out per calibration procedure (refer to table 5.2).	a) R44, R48 adjustments. b) Waveform symmetry, table 6-8. c) U8 circitry.
7.	Check sine amplitude vs frequency per specifications (refer to Section 1).	a) 50Ω cable >3 ft long b) C51, U10 c) C30, 32, 33, 34, 54 d) U9, Q8, Q9.

Table 6-5. Square Function

Indication: Square waveform problem, triangle OK.

	Check	If Faulty, Check
1.	Set controls to initial positions (refer to paragraph 6.3), except set Function to ⊓ .	Check for normal operation.
2.	Check CR19 cathode for a 2 kHz, approximately ±2V square wave.	a) Q6 circuit b) U6A. c) SW2F.
3.	Check U10 pin 6 for a ±1V square.	SW2F.
4.	Check square wave at Func Out for same 20 Vp-p (open circuit) amplitude as the triangle and sine.	U8 circuit.
5.	Check rise/fall times of 2MHz square (600Ω terminated) for <150 ns.	a) 50Ω cable >3 feet long b) C51, U10 c) C30, 32, 33, 34, 54 d) U9, Q8, Q9.

Table 6-6. TTL Sync Output

Indication: TTL sync output problem.

	Check	If Faulty, Check
1.	Set controls to initial positions (refer to paragraph 6.3).	Check for normal operation.
2.	Check U6 pin 5 for a TTL level, 2 kHz square.	Go to table 6-2.
3.	Check U6 pin 6 for a TTL level, 2 kHz square	a) U6 b) CR16, CR17.
4.	Check Sync Out (TTL).	J3.
5.	Check Sync Out waveform at 2MHz, using a TTL load termination of a ⩾600Ω resistive termination and ⩽3 foot RG58U coax.	U6.

Table 6-7. VCG Circuit

Indication: Generator does not respond correctly to dial and VCG input.

	Check	If Faulty, Check
1.	Set controls to initial positions (refer to paragraph 6.3).	Check for normal operation.
2.	Check for approximately +13V at E2.	a) E1, E2 and E3 wiring. b) +15V supply. c) Dial potentiometer, R1.
3.	Check E2 for appproximately +13V to 0V as dial is rotated from 2.0 to .002.	a) E1, E2, E3 wiring. b) Dial potentiometer, R1.
4.	Check U2 pin 7 for approximately −10 to −15V and pin 13 for approximately +10 to +15V as dial is rotated rom 2.0 to .002.	a) U1 b) U2 c) CR3−6.
5.	Check dial tracking of ×1K range.	a) Dial not mounted correctly at 0.1 ×1K frequency. b) Dial potentimeter, R1.
6.	Check for nonlinearity in the ±1.25V triangle at the emitter of Q3 near the bottom of the ×1K through ×1M ranges.	a) Associated timing capacitors or C6. b) U3, CR7 c) Q2, U4.
7.	Check frequencies of ×1K, ×10K and 100K ranges.	a) Adjust R2. b) C9, 10, and 11 (trimmed by C8).
8.	Check frequency and linearity of ×1M range.	a) C7 adjustment b) C6 c) C18, R25.
9.	Check frequencies ×1, ×10 and ×100 ranges.	R13−17 and table 6-9.

Table 6-8. Symmetry

Indication: Waveform symmetry problem.

	Check	If Faulty, Check
1.	Set controls to initial positions (refer to paragraph 6.3).	Check for normal operation.
2.	Check symmetry for problem which appears on ×1, ×10, ×100 ranges only.	a) R126 adjustment. b) Go to table 6-9.
3.	Perform step 4 of table 6-7, then return to this table.	R8, 9, 10, 11 matched to 0.2%.
4.	Verify RUN signal at acathod CR7 is approximately + 2V.	Go to table 6-10.
5.	Verify amplitude of SQR signal at cathode CR15 is approximately ±2V.	a) Q5 circuit. b) U5 circuit. c) + 5V supply.
6.	Check U3, CR7.	Replace if faulty.

Table 6-9. Capacitance Multiplier

Indication: Problem on bottom frequency ranges only.

	Check	If Faulty, Check
1.	Set controls to initial positions (refer to paragraph 6.3)	Check for normal operation on ×1K range.
2.	Set Frequency Multiplier to × 100. Check for 200 Hz, normal operation.	a) SW1A, SW1B b) R13, R16, R17.
3.	Check for 20 Hz and 2 Hz operation on × 10 and ×1 ranges.	a) SW1A, SW1B b) R14, R15.
4.	Check symmetry at 0.1 ×100; verify the triangle is linear.	a) R126 adjustment b) Q2, U4 c) Leaky C11, C12, C6, C7.
5.	Verify the generator runs; approximately symmetry and linear triangle at .002 ×100.	a) R126 adjustment b) Q2, U4 c) Leaky C11, C12, C6, C7.

Table 6-10. Trigger Logic

Indication: Generator trigger and gate mode problems.

	Check	If Faulty, Check
1.	Set controls to initial positions (refer to paragraph 6.3).	Check for normal continuous operation.
2.	If generator operates normally in continuous mode. Go to step 6.	
3.	Check for 0V at U5 pin 5 and U7 pin 10.	a) SW2A b) U6.
4.	Check for TTL High at U7 pin 9.	a) U7 b) CR20, CR40, Q7 c) Q1.
5.	Check for approximately +2V at anode CR7. Check for normal continuous mode operation.	a) CR7, Q1, Q7 b) Go to table 6-2.
6.	Check that Q1 emitter varies from approximately −10V to −15V as dial is rotated from 2.0 to .002.	a) Q1, R12 b) Go to table 6-7.
7.	Go to gated mode (Cont depressed, Trig/Gate released). Check U5 pin 5 for a TTL high.	a) U7 b) SW2A, SW2C, +5V supply.
8.	Check U5 pin 4 for a TTL Low.	a) U5 b) R34, R40, R41, CR21, CR22, ±5V supply.
9.	Check U6 pin 8 and U7 pin 10 for a TTL high.	a) U6 b) SW2B.
10.	Check U10 pin 9 for TTL low.	a) U10 b) Q7.
11.	Check anode CR7 for approximately −1.5V.	a) Q7 circuit b) CR7.
12.	Check cathode CR6 for approximately −0.7V.	a) U3 b) Q1.
13.	Check emitter Q3 for 0 Vdc ±10 mV.	a) U4, U3 b) Q2−Q4 circuitry.
14.	Connect an external TTL signal to Trig In connector; check for the inverse of that signal at U7 pin 10.	a) J2 b) CR21, CR22 c) U5.
15.	Press Trig/Gate switch and check for an approximate 20 ns negative pulse at U7 pin 10 following the low-to-high transition of the external signal (increasing the frequency of the external generator makes this pulse more visible).	a) SW2B b) C22, R35, R36.

Table 6-10. Trigger Logic (Continued)

Check	If Faulty, Check
16. Remove the external signal and verify that U7 pin 5 goes from high to low when the Man Trig switch is held depressed.	a) SW2C b) U7.
17. Release the Trig/Gate switch (gated) and check that U7 pin 10 goes from high to low when the Man Trig switch is pressed.	a) SW2A b) U5
18. Monitor Func Out (600Ω), triangle function, for 0 Vdc baseline.	R62, R104 adjustments.
19. Press Man Trig switch and check Func Out (600Ω) for a continuous triangle while the switch is held. Depress Trig/Gate switch (triggered) and verify one cycle each time Man Trig is pressed.	a) U7 or clock signal to U7 from U5. b) C22 (pulse too narrow).

6.4 TROUBLESHOOTING INDIVIDUAL COMPONENTS

6.4.1 Transistor

1. A transistor is defective if more than one volt is measured across its base-emitter junction in the forward direction.
2. A transistor when used as a switch may have a few volts reverse bias voltage across base-emitter junction.
3. If the collector and emitter voltages are the same, but the base emitter is less than 500 mV forward voltage (or reversed bias), the transistor is defective.
4. A transistor is defective if its base current is larger than 10% of its emitter current (calculate currents from voltage across the base and emitter series resistors).
5. In a transistor differential pair (common emitter stages), either their base voltages are the same in normal operating condition, or the one with less forward voltage across its base emitter junction should be off (no collector current); otherwise, one of the transistors is defective.

6.4.2 Diode

A diode (except a zener) is defective if there is greater than one volt (typically 0.7 volt) forward voltage across it.

6.4.3 Operational Amplifier

1. The "+" and "−" inputs of an operational amplifier will have less than 15 mV voltage difference when operating under normal conditions.
2. When the output of the amplifier is connected to the "−" input (voltage follower connection), the output should be the same voltage as the "+" input voltage; otherwise, the operational amplifier is defective.
3. If the output voltage stays at maximum positive, the "+" input voltage should be more positive than the "−" input voltage, or vice versa; otherwise, the operational amplifier is defective.

6.4.4 FET Transistor

1. No gate current should be drawn by the gate of an FET transistor. If so, the transistor is defective.
2. The gate-to-source voltage is always reverse biased under a normal operating condition; e.g., the source voltage is more positive than the gate voltage for 2N5485, and the source voltage is more negative than gate voltage for a 2N5462. Otherwise, the FET is defective.
3. If the device supplying gate voltage to an FET saturates, the FET has too large a Vgs (pinch off) for the circuit and should be replaced.

6.4.5 Capacitor

1. Shorted capacitors have zero volts across their terminals.
2. Opened capacitor can be located (but not always) by using a good capacitor connected in parallel with the capacitor under test and observing the resulting effect.

SECTION 7
PARTS AND SCHEMATICS

7.1 DRAWINGS

The following assembly drawings (with parts lists) and schematics are in the arrangement shown below.

7.2 ORDERING PARTS

When ordering spare parts, please specify part number, circuit reference, board, serial number of unit, and, if applicable, the function performed.

7.3 ERRATA

Under Wavetek's product improvement program, the latest electronic designs and circits are incorporated into each Wavetek instrument as quickly as development and testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, errata pages are prepared to summarize the changes made and are inserted inside the shipping carton with this manual. If no such pages exist, the manual is correct as printed.

DRAWING	DRAWING NO.
Chassis Assembly	1101-00-1324
Chassis Parts List	1101-00-1324
PCA Generator Schematic	0103-00-1323
PCA Generator Assembly	1100-00-1323
PCA Generator Parts List	1100-00-1323

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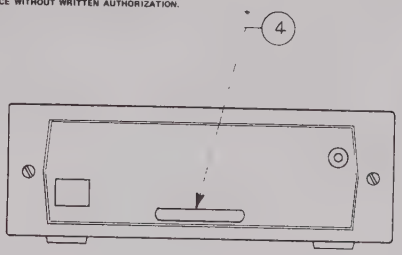
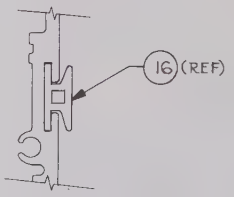
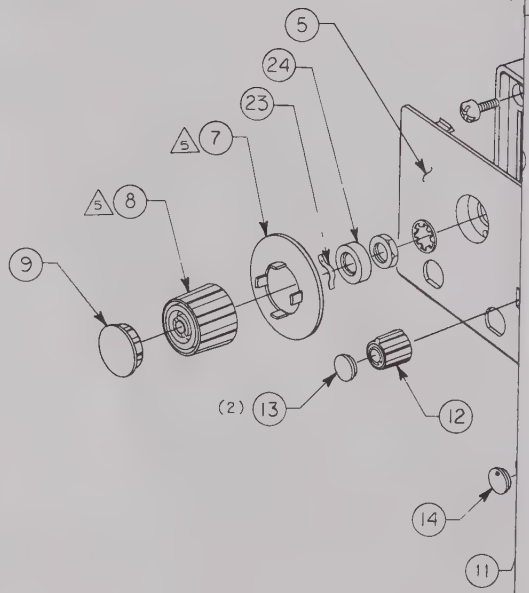
REV	ECN	BY	DATE	APP
A	RELEASE			
B	#4881			A.R.T.
C	#6137	ACT	2/25/86	A.R.T.
D	#7255	[illegible]	3/27/86	A.R.T.



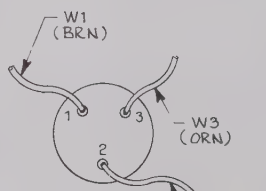
REAR VIEW



DETAIL "A"
(SCALE: 2/1)



WIRE HOOKUP LIST			
REF DES	COLOR	FROM	TO
W1	BRN	E1	A3R1-1
W2	RED	E2	A3R1-2
W3	ORN	E3	A3R1-3
W4	GRN/YEL	E4	A7E5



R1
WIRE HOOKUP
(SCALE: NONE)

5. ASSEMBLE DIAL AND KNOB BEFORE PLACING ON CHASSIS.
   A. SNAP KNOB (1401-01-8300) ONTO DIAL (1400-01-8370).
   B. APPLY ADHESIVE (1600-03-0013) TO DIAL TABS (4 PLACES).
4. 1201-00-1114 (TOP COVER) & 1201-00-1136 (BOTTOM COVER) ARE PART OF THE NEXT ASSEMBLY 1000-00-0274.
3. WIRES ARE OBTAINED FROM 1207-00-1460 (WIRE KIT).
2. REFERENCE DESIGNATIONS DO NOT APPEAR ON PARTS.
1. SEE 0004-00-0274 FOR INSTRUMENT SCHEMATIC.

NOTE UNLESS OTHERWISE SPECIFIED

SEPARATE PARTS LIST 1101-00-1324

DRAWN	DATE 11/29/84	WAVETEK SAN DIEGO, CALIFORNIA	
ENGR	12/18/84	TITLE	
APPROV	1-18-85	ASSY, CHASSIS (A3)	
TOLERANCE UNLESS OTHERWISE SPECIFIED .10 ANGLES ±1 .30			
NOT SCALE DWG		MODEL NO. 20	DWG NO. 1101-00-1324 REV D
NONE		CODE IDENT 23338	SHEET 1 OF 1

BISHOP GRAPHICS ACCUPRESS REORDER NO. A1706

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REV	ECN	BY	DATE	APP

PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
POT, DIAL, 5K+/-5%, PRECISION, LINEAR	ECONOPOT MKIII	NEI	4600-05-0212	1

TLE	ASSEMBLY NO.	REV
SSY, CHASSIS	1101-00-1324	D

PAGE 3

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE
MATERIAL	PROJ ENGR	
	RELEASE APPROV	
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ±1 XX ± .030	
	DO NOT SCALE DWG	
	SCALE	

WAVETEK SAN DIEGO • CALIFORNIA

TITLE
PARTS LIST
ASSY, CHASSIS

MODEL NO	DWG	REV
20	1101-00-1324	D
CODE IDENT 23338	SHEET 1 of 1	

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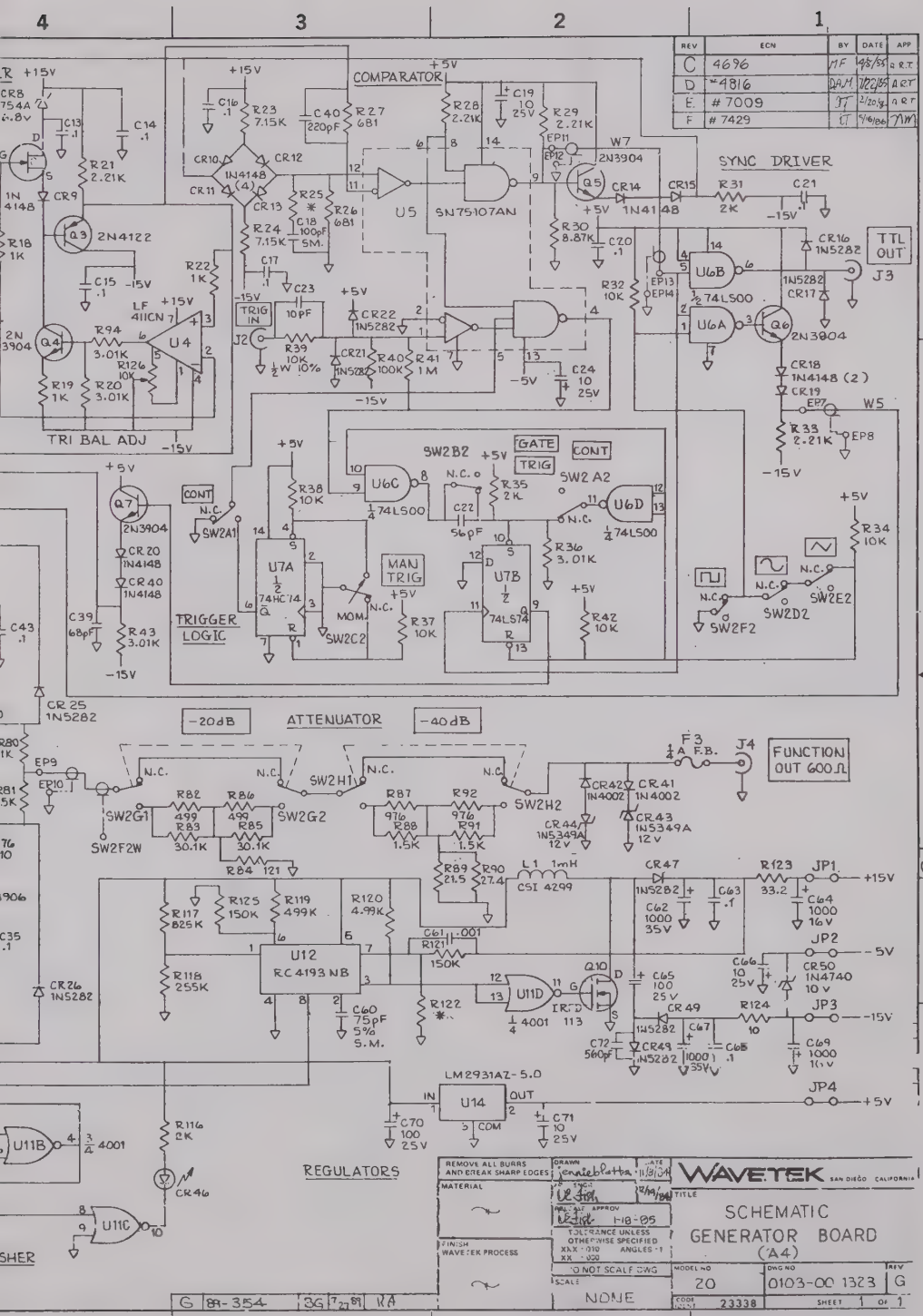
REORDER NO. A/GRA


4
3
2
1
REV | ECN | BY | DATE | APP
C | 4696 | MF | 4/8/85 | R.R.T.
D | 4816 | DAM | 12/2/85 | R.R.T.
E | # 7009 | JT | 2/20/86 | R.R.T.
F | # 7429 | JT | 9/16/86 | MM
COMPARATOR
SYNC DRIVER
U5 SN75107AN
U4 LF 411CN
TRI BAL ADJ
TRIGGER LOGIC
MAN TRIG
GATE
TRIG
CONT
SW2B2
SW2A2
SW2A1
SW2C2
SW2E2
SW2D2
SW2F2
SW2F2W
SW2G1
SW2G2
SW2H1
SW2H2
-20dB
ATTENUATOR
-40dB
FUNCTION OUT 600Ω
TTL OUT
REGULATORS
LM2931AZ-5.0
U12 RC4193NB
U11D
U11B
U11C
Q10 IRF 113
CSI 4299
WAVETEK SAN DIEGO CALIFORNIA
SCHEMATIC GENERATOR BOARD (A4)
MODEL NO 20
DWG NO 0103-00 1323
REV G
SCALE NONE
SHEET 1 OF 1
G 88-354 8G 7/21/89 WA

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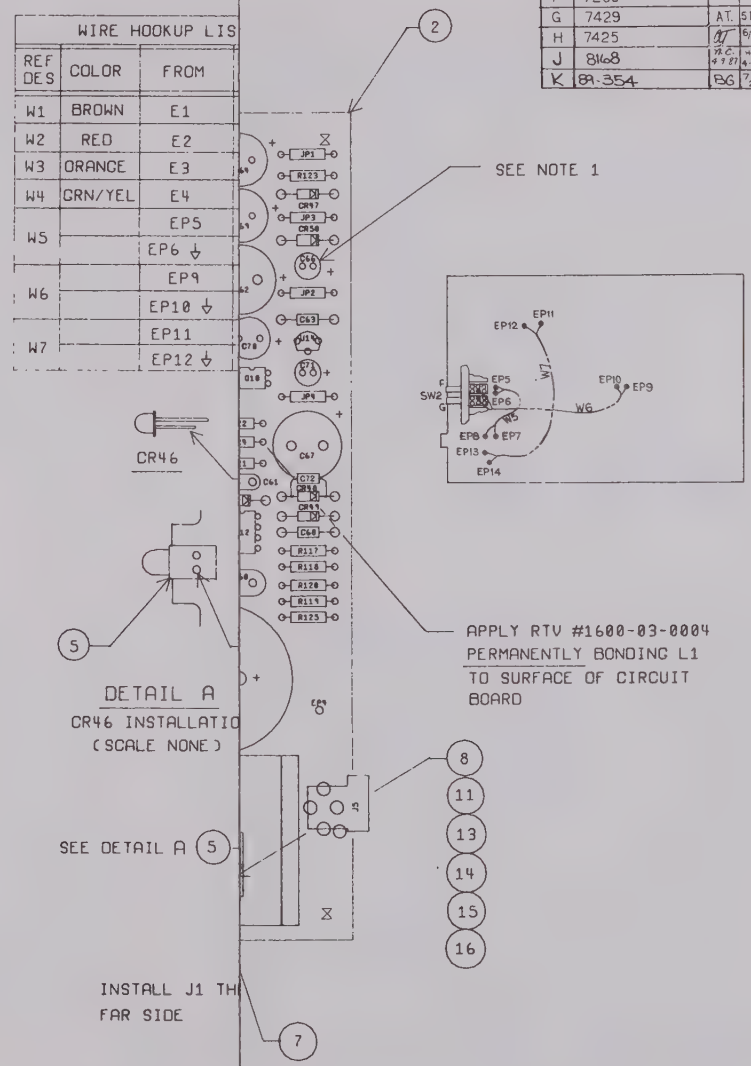
REV	ECN	BY	DATE	APP
C	4696	K.A.	3/27/85	
D	4816, 4892	B.R. A.T.	7/15/86	A.R.T.
E	7009	B.R.	7/21/86	A.R.T.
F	7209	—	—	—
G	7429	A.T.	5.16.86	A.R.T.
H	7425	A.T.	6/11/86	A.R.T.
J	8168	R.C. 4.7.87	4.8.87	H.W.
K	89-354	BG	7/27/89	KA

WIRE HOOKUP LIS

REF DES	COLOR	FROM
W1	BROWN	E1
W2	RED	E2
W3	ORANGE	E3
W4	GRN/YEL	E4
W5		EP5
		EP6 ⏚
W6		EP9
		EP10 ⏚
W7		EP11
		EP12 ⏚



5. WIRE OBTAINED FROM WIRE KIT 1207-00-1460
4. FOR ASSEMBLY INTERCONNECTION, SEE INSTRUME SCHEMATIC 0004-00-0274
3. SEE 0103-00-1323 FOR SCHEMATIC DIAGRAM
2. PARTIAL REFERENCE DESIGNATIONS SHOWN, PREF WITH ASSEMBLY REFERENCE DESIGNATION A4.
1. REFERENCE DESIGNATIONS DO NOT APPEAR ON PA

NOTE UNLESS OTHERWISE SPECIFIED

SEE SEPARATE PARTS LIST 1100-00-1323

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN 12/19/84	WAVETEK SAN DIEGO, CALIFORNIA	
MATERIAL	PROJ. ENGR D.E. FISH 12/19/84	TITLE PCA GENERATOR (A4)	
	RELEASE APPROV D.E. FISH 1/18/85		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ±1° XX ±.03		
	DO NOT SCALE DWG	MODEL NO 20	DWG NO 1100-00-1323 REV K
	SCALE NONE	CODE IDENT 23338	SHEET 1 OF 1

1100-00-1323 K

REV	ECN	BY	DATE	APP

	MFGR	WAVETEK NO	QTY/PT
	AMP	2100-01-0019	4
	BURND	2100-03-0066	1
	MOUSR	2100-03-0075	1
	ARTWR	2100-05-0024	1
	LITFU	2400-05-0017	1
	LITFU	2400-05-0019	1
	BUSS	2400-05-0021	1
	COMPO	2400-05-0041	6
	HP	2400-06-0008	1
	MOUSR	2400-06-0009	1
	MOT	2800-11-0015	1
	AHAM	2800 11-0020	1
	AVDEL	2800-12-0043	2
	CMRCL	2800-16-4100	1
	CMRCL	2800-26-4000	2
	CMRCL	2800-26-4001	2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R114 R40	RES, MF, 1/8W, 1%, 100K	RN55D-1003F	TRW	4701-03-1003	2
R41	RES, MF, 1/8W, 1%, 1M	RN55D-1004F	TRW	4701-03-1004	1
R113	RES, MF, 1/8W, 10M	5033YD10M000F	MEPCO	4701-03-1005	1
R124 R73 R76	RES, MF, 1/8W, 1%, 10	5043ED10R100F	MEPCO	4701-03-1009	3
R84	RES, MF, 1/8W, 1%, 121	RN55D-1210F	TRW	4701-03-1210	1
R101T	RES, MF, 1/8W, 1%, 1 21K	RN55D-1211F	TRW	4701-03-1211	1
R122T	RES, MF, 1/8W, 1%, 12 4K	RN55D-1242F	TRW	4701-03-1242	1
R3	RES, MF, 1/8W, 1%, 13 3K	RN55D-1332F	TRW	4701-03-1332	1
R5L	RES, MF, 1/8W, 1% 1 37K	MEPCO	RN55D13	4701-03-1371	1
R81 R88 R91	RES, MF, 1/8W, 1%, 1 5K	RN55D-1501F	TRW	4701-03-1501	3
R121 R125 R63	RES, MF, 1/8W, 1%, 150K	RN55D-1503F	TRW	4701-03-1503	3
R50 R53	RES, MF, 1/8W, 1%, 165	RN55D-1650F	TRW	4701-03-1650	2
R59 R77	RES, MF 1/8W, 1%, 1 96K	RN55D-1961F	TRW	4701-03-1961	2
R1 R116 R31 R35	RES, MF, 1/8W, 1%, 2K	RN55D-2001F	TRW	4701-03-2001	4
R71 R89	RES, MF, 1/8W, 1%, 21 5	RN55D-21R5F	TRW	4701-03-2159	2
R60	RES, MF, 1/8W, 1%, 221	RN55D-2210F	TRW	4701-03-2210	1

LY NO. 1100-00-1323 REV K

PAGE 3

WAVETEK PARTS LIST

TITLE ASSY, PCA, GENERATOR A4

ASSEMBLY NO. 1100-00-1323 REV K

PAGE 5

	MFGR	WAVETEK NO.	QTY/PT
	COMI.	2800-38-4106	1
	CMRCL	2800-42-4000	1
	CHOMR	3100-00-0010	1
	BECK	4600-01-0315	1
	BECK	4600-01-0402	2
	BECK	4600-02-0101	1
	BECK	4600-02-0201	1
	BECK	4600-05-0104	1
	WVTK	4602-01-0325	1
	WVTK	4609-71-0201	1
	MEPCO	4700-13-0109	1
	STKPL	4700 25-0279	1
	STKPL	4700 25-1002	1
	TRW	4701-03-1001	5
	TRW	4701-03-1002	5

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
R105 R21 R28 R29 R33	RES, MF, 1/8W, 1%, 2 21K	RN55D-2211F	TRW	4701-03-2211	5
R46	RES, MF, 1/8W, 1%, 249	RN55D-2490F	TRW	4701-03-2490	1
R12 R13	RES, MF, 1/8W, 1%, 2 49K	RN55D-2491F	TRW	4701-03-2491	2
R14 R70	RES, MF, 1/8W, 1%, 24 9K	RN55D-2492F	TRW	4701-03-2492	2
R15	RES, MF, 1/8W, 249K	RN55D-2493F	TRW	4701-03-2493	1
R118	RES, MF, 1/8W, 1%, 255K	RN55D-2553F	TRW	4701-03-2553	1
R25T	RES, MF, 1/8W, 1%, 2 74K	RN55D-2741F	TRW	4701-03-2741	1
R102 R103	RES, MF, 1/8W, 1%, 27 4K	RN55D-2742F	TRW	4701-03-2742	2
R90	RES, MF, 1/8W, 1%, 27 4	RN55D-27R4F	TRW	4701-03-2749	1
R17	RES, MF, 1/8W, 1%, 301	RN55D-3010F	TRW	4701-03-3010	1
R100 R20 R36 R43 R94	RES, MF, 1/8W, 1%, 3 01K	RN55D-3011F	TRW	4701-03-3011	5
R49 R52 R83 R85	RES, MF, 1/8W, 1%, 30 1K	RN55D-3012F	TRW	4701-03-3012	4
R78	RES, MF, 1/8W, 1%, 332	RN55D-3320F	TRW	4701-03-3320	1
R16T R56 R57	RES, MF, 1/8W, 1%, 3 32K	RN55D-3321F	TRW	4701-03-3321	3
R51 R54	RES MF, 1/8W, 1%, 33 2K	RN55D-3322F	TRW	4701-03-3322	2
R123	RES, MF, 1/8W, 1%, 33 2	RN55D-33R2F	TRW	4701-03-3329	1

ILY NO. 1100-00-1323 REV K

PAGE 4

WAVETEK PARTS LIST

TITLE ASSY, PCA, GENERATOR A4

ASSEMBLY NO. 1100-00-1323 REV K

PAGE 6

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJENGR		TITLE: PARTS LIST PCA GENERATOR
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1 XX ±.030		
	DO NOT SCALE DWG		MODEL NO 20 / DWG NO 1100-00-1323 / REV K
	SCALE		CODE IDENT 23338 / SHEET 1 OF 2

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REV	ECN	BY	DATE	APP

PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
TRANS 2N3906 PNP GENERAL PURPOSE TO-92	2N3906	FAIR	4901-03-9060	1
TRANS, GENERAL PURPOSE, PNP, TO-92	2N4122	NSC	4901-04-1220	2
TRANS, N-CHANNEL JFETS	2N5485	MOT	4901-05-4850	1
TRANS, POWER MOSFET	IRFD113	IR	4902-00-1130	1
SWITCH ASSY, PB	5103-00-0045	WVTK	5103-00-0045	1
SWITCH ASSY, ROTARY	5104-00-0025	WVTK	5104-00-0025	1
OP AMP, DUAL JFET INPUT	TL083CN	TI	7000-00-8300	1
VOLT REGULATOR, 3 TERMINAL ADJUSTABLE POS	LM317T	NSC	7000-03-1700	1
OP AMP, HIGH SPEED	LT318ANB	LINTE	7000-03-1802	1
OP AMP, LOWOFFSET/DRIFT JFET INPUT	LF411CN	NSC	7000-04-1100	1
REG, LINEAR, 5V	LM2931AZ-5.0	NSC	7000-29-3150	1
DIODE, ULTRA FAST, LOW CAPACITANCE	CA-3019	RCA	7000-30-1900	2
TRANS ARRAY, NPN/PNP	CA-3096AE	RCA	7000-30-9600	1

TITLE	ASSEMBLY NO.	REV
ASSY, PCA, GENERATOR A4	1100-00-1323	K
	PAGE 9	

PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO	QTY/PT
TRANS ARRAY, HIGH VOLTAGE	CA3146E	RCA	7000-31-4600	1
REGULATOR SWITCHING, VARIABLE	RC4193NB	RAYTH	7000-41-9300	1
RECEIVER, DUAL LINE	SN75107AN	TI	7007-51-0700	1
GATE, NOR QUAD 2 INP, CMOS	CD4001BE	RCA	8000-40-0100	1
GATE, NAND, QUAD 2-INP, TTL	SN74LS00N	TI	8000-74-0010	1
FLIP-FLOP DUAL, D-POS EDGE TRIG, TTL	74LS74	TI	8000-74-7410	1

TITLE	ASSEMBLY NO.	REV
ASSY, PCA, GENERATOR A4	1100-00-1323	K
	PAGE 10	

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR		TITLE: PARTS LIST PCA GENERATOR
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ±1 XX ±.030		MODEL NO 20
	DO NOT SCALE DWG		DWG NO 1100-00-1323
	SCALE		REV K
			CODE IDENT 23338
			SHEET 2 OF 2

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